IS 4479 (1981): Methods of measurement on magnetic tapes for sound recording and reproduction [LITD 7: Audio, Video and Multimedia Systems and Equipment]

BLANK PAGE

IS : 4479 - 1981
(Reaffirmed 2001)

Indian Standard

METHODS OF MEASUREMENT ON MAGNETIC TAPES FOR SOUND RECORDING AND REPRODUCTION

(First Revision)

UDC 681·84·083·84:620·16

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Price Rs 10·00 *September* 1981

Indian Standard

METHODS OF MEASUREMENT ON MAGNETIC TAPES FOR SOUND RECORDING AND REPRODUCTION

(First Revision)

Recording Sectional Committee, LTDC 23

Chairman	*Representing*
SHRI P.R. NARASIMHAN	Directorate General of All India Radio, New Delhi
Members	
SHRI J.N. BISARIA (*Alternate to* Shri P.R. Narasimhan)	
SHRI L.H. BHATIA	Polydor of India Ltd, Bombay
SHRI N.P. BHATTACHARYA	Department of Teaching Aids, New Delhi
DR A.F. CHHAPGAR	National Physical Laboratory (CSIR), New Delhi
SHRI P.H. GANATRA	Vimal Enterprises Ltd, Umbergam
SHRI M. SAJJAD (*Alternate*)	
SHRI D.K. GHOSH	The Gramophone Co of India Ltd, Calcutta
SHRI ARUN BAGRI (*Alternate*)	
DR R.G. GUPTA	Department of Electronics, New Delhi
DR P.N. GUPTA (*Alternate*)	
COL L.G. KETKAR	Ministry of Defence (DGI)
LT COL G.R. MAHADEVAN (*Alternate*)	
DR C.G. KHOT	Railway Board, New Delhi
SHRI S. JAIN (*Alternate*)	
SHRI S.C. MAZUMDAR	General Electronics of Haryana Pvt Ltd, Faridabad
SHRI M.N. MEHTANI	Directorate General Doordarshan, New Delhi
SHRI S.S. SWANI (*Alternate*)	
SHRI A.G. NARASIMHA	Directorate General of Civil Aviation, New Delhi
SMT V. RATNAVATI (*Alternate*)	
SHRI S.C. PATEL	Bharat Electronics Ltd, Bangalore
SHRI K.D. PAVATE	Central Electronics Engineering Research Institute (CSIR), Pilani
SHRI M.R. KAPOOR (*Alternate*)	
SHRI A. V. RAMANAN	Films Division, Bombay
SHRI P.D. RAO	Electronic Component Industries Association (ELCINA), New Delhi
SHRI P.V. KRISHNA REDDI	Film and Television Institute of India, Pune

(*Continued on page* 2)

(*Continued from page* 1)

Members	*Representing*
RESEARCH ENGINEER SHRI M. SANKARALINGAM	Research Department, All India Radio, New Delhi Directorate General of Supplies & Disposals (Inspection Wing)
SHRI J.S. PASSI (*Alternate*)	
SHRI S.K. SARAF	Peico Electronics and Electricals Ltd, Bombay ; *and* The Radio Electronic & Television Manufacturers Association, Bombay
SHRI A. DAS GUPTA (*Alternate*)	
SHRI R.C. JAIN, Head (Electronics)	Director General, ISI (*Ex-officio Member*)

Secretary

SHRI PAVAN KUMAR

Assistant Director (Electronics)

Panel for Magnetic Tapes for Sound Recording and Reproduction, LTDC 23 : P1

Convener	
DR A.F. CHHAPGAR	National Physical Laboratory (CSIR), New Delhi
Members	
SHRI J.N. BISARIA	Directorate General of All India Radio, New Delhi
SHRI P.H. GANATRA	Vimal Enterprises Ltd, Umbergam
SHRI M. SAJJAD (*Alternate*)	
SHRI D.K. GHOSH	The Gramophone Co of India Ltd, Calcutta
SHRI ARUN BAGRI (*Alternate*)	
RESEARCH ENGINEER SHRI M. SANKARALINGAM	Research Department, All India Radio, New Delhi Directorate General of Supplies & Disposals (Inspection Wing)
SHRI J.S. PASSI (*Alternate*)	

Indian Standard

METHODS OF MEASUREMENT ON MAGNETIC TAPES FOR SOUND RECORDING AND REPRODUCTION

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 13 May 1981, after the draft finalized by the Recording Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard covers the methods for the measurement of the essential characteristics of magnetic tapes for sound recording and reproduction.

0.3 This standard was originally published in 1967. The revision has been undertaken to include methods of measurements on magnetic tapes (cassette type) also.

0.3.1 The tests for friction coefficient, flexibility and drop out annoyance value (*h*) are under consideration and will be incorporated in this standard after information on the suitable methods of measurement is obtained.

0.4 Specifications for magnetic tapes for sound recording and reproduction are covered by the following standards:

IS : 4377-1967 General requirements for magnetic tapes for sound recording and reproduction.

IS : 4480 (Part I)-1967 Magnetic tapes for sound recording and reproduction : Part I Domestic grade.

IS : 4480 (Part II)-1974 Magnetic tapes for sound recording and reproduction : Part II Professional grade.

IS : 9702-1980 Magnetic tape for cassettes for sound recording and reproduction.

0.5 While preparing this standard, assistance has been derived from IEC Doc : 60A (Sectt) 78 ' Revision of IEC Pub 94 : Magnetic tape recording and reproducing systems. Draft-proposal for IEC Pub 94 : Part 5 Methods of measuring the electrical properties of magnetic tape for analogue sound recording and reproduction, issued by International Electrotechnical Commission.

0.6 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard lays down the methods of measurement for determining the physical, mechanical and electrical performance characteristics of magnetic tapes for sound recording and reproduction.

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in IS : 1885 (Part XLVIII)/Sec 1)-1978† shall apply in addition to the following.

2.1 Reference Tape (*See* **Appendix A**) — An unrecorded tape with specified sensitivity, distortion and bias characteristic.

2.2 Calibration Tape — A tape on which specified signals and flux levels have been recorded.

2.3 Reference Level — The flux level of the reference level part of the appropriate calibration tape.

2.4 Maximum Output Level — On a magnetic recording medium the value of recording level at which:

a) a specified percentage of distortion occurs, or

b) the magnetic material has attained saturation.

NOTE — Saturation is the state of a ferromagnetic material subjected to an external magnetic field of such intensity that the induced magnetization cannot be substantially increased by further strengthening of the magnetic field.

2.4.1 Maximum output level is expressed in decibels relative to the output level obtained when replaying the reference level.

2.5 Maximum Recording Current — The recording current necessary to obtain maximum output level from the reference tape at reference bias.

2.6 Biasing Current — A high frequency current passing through the coils of a recording head which produces the biasing magnetic field.

a) *Professional Tapes* — [For tape speeds of 76·2 cm/s, 38·1 cm/s, and 19·05 cm/s.]

That bias current which corresponds to the minimum third harmonic distortion from the tape being measured. It is expressed

*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary: Part XLVIII Recording, Sec 1 Tape recording.

in decibels as a ratio relative to the reference bias of the reference tape. The reference bias may be determined by using a frequency analyser or filter.

b) *Domestic Tapes* — [For tape speeds of 19·05 cm/s, 9·53 cm/s and 4·76 cm/s (including 3·81 mm).]

That bias current which result in a specified value of 315 Hz maximum output level (1 kHz for 19·05 cm/s tape speed) from the reference tape based on a third harmonic distortion measurement. (*see* Appendix B).

NOTE — The reference bias current is the bias current specified for use in the tests of this specification. It is not necessarily the best operational bias current; this may be separately quoted in the manufacturer's published data, together with any relevant test results and or/curves.

2.7 Noise

2.7.1 *Reference Level to Bulk Erase Level* — The ratio, expressed in decibels of the reference level output to the weighted noise output [*see* IS : 8655 (Part I)-1977*] after bulk erase (without machine erase and bias).

2.7.2 *Reference Level to Bias Noise Level* — The ratio, expressed in decibels of the reference level output to the weighted noise output [*see* IS : 8655 (Part I)-1977*] after machine erase, with reference bias applied.

2.7.3 *Signal-to-Noise Ratio* — The ratio, expressed in decibels of the maximum output level at a specified frequency with reference bias to the weighted bias noise level [*see* IS : 8655 (Part I)-1977*].

2.8 Modulation Noise — All noise appearing with and dependent upon the presence of the recorded audio signal.

2.8.1 *DC Noise Level* — The noise level resulting from the application to the recording head of a direct current equivalent to the rms value of the current required for maximum output level at a specified frequency with reference bias.

2.8.2 *Signal to DC Noise Level Ratio* — The ratio expressed in decibels of the maximum output level to the weighted dc noise level [*see* IS : 8655 (Part I)-1977*] at a specified frequency with reference bias.

NOTE — The major components of modulation noise are:

Asperity Noise — The noise due to amplitude modulation of the recorded information caused by micro inhomogeneities and surface imperfections of the tape.

Friction Noise — The noise due to frequency modulation of the recorded information caused by friction between the tape transport system and the moving tape.

*Magnetic sound tape recording and reproducing equipment (reel-to-reel): Part I Methods of measurement.

2.9 Uniformity Variations — Uniformity variations are continuously recurring variations of a periodic or non-periodic nature during the reproduction of a recorded signal on a magnetic tape.

2.9.1 *Short Term Uniformity Variations* — have a duration of between 40 milliseconds and 1 second and do not include drop-outs.

2.9.2 *Long Term Uniformity Variations* — have a duration of greater than 1 second.

2.10 Drop-Out — A serious momentary reduction of the reproduced signal level.

2.10.1 *Drop-Out Annoyance* — The subjective annoyance caused by drop-outs taking into account the depth, duration and repetition rate of these drop-outs.

2.11 Sensitivity

2.11.1 *Relative Tape Sensitivity* — The ratio expressed in decibels of the output levels obtained from the tape under test and the reference tape, respectively, when a recording current (sufficiently below maximum recording current to ensure linearity, for example, 20 dB) is applied using the respective applicable reference bias.

2.11.2 *Reverse Relative Tape Sensitivity* — The difference between the relative tape sensitivity of the tape under test and its relative tape sensitivity with the direction of travel reversed at a specified frequency.

2.12 Print Through — The ratio, expressed in dB, of the maximum output level at a specified frequency and bias, to that of the largest signal obtained by print through onto either of the adjacent layers, after incubation for a specified period at a specified temperature.

2.13 Erasing Attenuation — The difference, expressed in decibels, between the level of a signal recorded on a tape, and the remaining level of that signal on the same tape, after erasure.

2.13.1 Erasure — A process by which a previous recording is removed from a magnetic medium.

2.14 Tape Lap — The total angular displacement of the tape by the head.

3. GENERAL REQUIREMENTS FOR MEASUREMENTS

3.0 Unless otherwise specified, the measurements shall be made under the following conditions.

3.1 Recording and Replay Equipment — Recording and replay equipment shall be in accordance with the requirements of Appendix C as to the

mechanical properties of the tape transport mechanism, including tape tension; the types and details of heads to be used; and the electrical properties of bias and erase supplies and of recording and replay amplifiers.

3.2 Cassette tapes under test shall be rewound on spool and shall be tested by reel-to-reel recorder.

3.3 Accuracy of Test Set-up — The test set-up employed to carry out measurements in accordance with this standard shall have an accuracy of at least one order better than that specified for the parameter under measurement.

3.4 Tape Speeds — Tests shall be made at the nominal tape speeds specified below:

Type of Tape	*Speed* cm/s	*Tolerance* %
a) *Reel-to-reel*		
i) Professional	38·1	± 0·2
ii) Domestic	9·53	± 2
b) *Cassette*		
i) Commercial	4·76	± 0·5
ii) Domestic	4·76	± 2

3.5 Nominal Width of Tape — These tests are applicable on tapes for professional and domestic use, having width of:

a) 6·30—0·06 mm for reel-to-reel tape and

b) 3·81—0·05 mm for cassette tape.

3.6 Atmospheric Conditions for Testing

3.6.1 Unless otherwise specified all measurements shall be made under the following atmospheric conditions:

Temperature	15	to	35°C
Relative humidity	45	to	75 percent
Air pressure	86	to	106 kPa

3.6.2 Where necessary the tests shall be preceded by a period of conditioning to ensure that the test item has reached equilibrium with the ambient environment.

3.7 Frequencies of Measurement

3.7.1 Unless otherwise specified the reference audio frequency for measurements shall be as follows:

Type of Tape	*Tape Speed* cm/s	*Reference Audio Frequency* Hz
a) *Reel-to-reel*		
i) Professional	38·1	1 000
ii) Domestic	9·53	315
b) *Cassette*	4·76	315

3.7.2 The frequencies for measurements shall be the specified range in the relevant clauses.

3.7.3 **Test Frequencies** — For measurements made at a number of frequencies, the frequencies shall be selected from Table 1 of IS : 2264-1963*.

3.8 Scales for Graphical Presentation of Data

3.8.1 *General* — Linear or logarithmic scales are recommended for graphical presentation. Linear decibel scales are equivalent to logarithmic scales. Other kinds of scales, such as double logarithmic, shall be avoided. When using decibel scales, the zero of reference should, if possible, be the rated value. In those cases, where each of the scales refers directly to physical units, it is recommended to avoid a combination of linear and logarithmic scales.

Where quantities represented by abscissae and ordinates are of the same kind, it is recommended that the same unit length be used for both. Linear scales with remote zero point should be avoided as far as possible.

3.8.2 *Scales for Frequency Characteristics* — Graphs shall be drawn with frequency in hertz as abscissa on a logarithmic scale, and the output level in decibels as ordinate on a linear scale. The scale ratio shall be such that the length representing one decade of frequency is the same as the length representing 25 dB or 50 dB difference in output level.

The preferred length per decade is 50 mm. If the size of the graph is changed, the scale ratio should be left unaltered.

4. PHYSICAL AND MECHANICAL TESTS

4.0 Preconditioning — Each reel of tape shall be preconditioned prior to the tests in order to relieve the stress and to establish uniform conditions in the tape. The tape shall be rewound under a tension of 2·0 N or less for reel-

*Preferred frequencies for acoustical measurements.

to-reel tape and 0·5 N or less for cassette tape. The tape shall then be subjected to temperature cycles as specified below:

a) For the first two hours at 55 ± 2°C and relative humidity not exceeding 20 percent.

b) For the next two hours, 27 ± 2°C and relative humidity 65 ± 5 percent.

At the end of the test cycle the reel of tape shall be immediately rewound atleast three times at a tension not exceeding 2·0 N.

The tape shall then be stored at 27 ± 2°C and relative humidity 65 ± 5 percent for a minimum period of 24 hours before any tests are made.

4.1 Visual Examination — The tape, and its housing shall be visually examined for checking the requirements specified in the relevant standard.

4.2 Width and Width Tolerance — Width and width tolerance shall be measured using a travelling microscope.

4.2.1 Use of 'go' and 'no-go' gauges is recommended for routine measurements of tape width and width tolerance. These gauges take the form of a small ground and polished hard steel flanged pulleys (*see* Fig. 1). The dimensions *h* corresponds to maximum width of the tape (*t* max) for go-gauge and to minimum width of the tapes (*t* min) for no-go gauge.

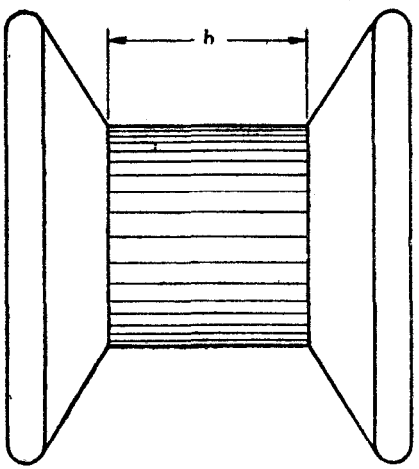


FIG. 1 TAPE WIDTH GAUGE

4.3 Thickness of Tape and Coating — Thickness measurement shall be carried out on a sample of tape of one metre length by the use of a suitable method like comparator for film and coating thickness capable of reading

down to 0·000 2 mm. At least ten measurements shall be made over the length at the random points. The total thickness is measured directly first, after which the coating is removed with suitable chemical such as Tetra Hydrofurone (THF), Methyl Isobutyl Ketone (MIBK) or Carbon Tetra Chloride and another measurement made. Subtracting one figure from the other gives the coating thickness.

4.4 Tape Length — The total length of the tape in a given reel/cassette shall be suitably measured for checking conformity with the length requirements.

4.5 Cupping (Humidity Stability)

4.5.0 Cupping or transverse curvature of the tape is generally the result of contractions of the coated dispersion during drying. It may also be due to a differential absorption of moisture by base and coating. It takes the form of a concavity on the coated side. Cupping leads to poor winding properties of the tape and tends to impose unequal strains over the tape width. It is also impossible to ensure the essential intimate contact between the tape and head all over the tape width when pronounced cupping is present without subjecting the tape to undesirable tension during use.

4.5.1 Test Procedure — The tape samples are exposed for a duration of 12 hours each:

a) first at a temperature between 38° and 42°C relative humidity of of less than 15 percent.

b) and then, at a temperature between 38° and 42°C and relative humidity between 90 and 100 percent.

At the end of the period of exposure the cupping shall be measured with goniometer or any other suitable instrument.

4.6 Anchorage

4.6.0 *General* — The poor anchorage may be manifested as a separation of the ferromagnetic coating from the base material of the magnetic recording tape or internal failure of the coating layer itself. In this test the tape shall be subjected to high temperature and humidity and then tested for anchorage.

4.6.1 A complete reel of tape shall be used. After conditioning according to **4.0** the reel shall be rewound so that the coated side is facing away from the hub under a tension of not less than 1·7 N for reel-to-reel tape and 0·4 N for cassette tape. The tape shall then be placed in a chamber at 55 ± 2°C and relative humidity 95 ± 5 percent for a period of 8 hours. After removal from the chamber the tape shall be placed on the standard reference recorder and rewound at fast forward speed and in addition to the normal tape guides, a smooth rod of 3 ± 0·4 mm in diameter shall be placed between the head assembly and the supply reel in such a manner that the tape effects a wrap of at least 90° on the rod while running with

the rod touching the base of the tape. The reel shall be examined for any evidence of anchorage failure. If no failure is noted, the tape shall be placed in a container at 27 ± 2°C and humidity less than 15 percent for a period of 24 ± 1 hours after which the fast rewind test shall be repeated and the tape examined for anchorage failure.

4.7 Layer-to-Layer Adhesion

4.7.1 A one-metre length of tape shall be suspended from a hollow tube to which the tape shall be attached magnetic side facing towards the centre of the tube with a non-oozing adhesive material. This tube shall be mounted on bearings so that it may be rotated freely around its central axis. The tube shall be made of some non-oxidizing metal, such as brass or corrosion resisting steel, should be 15 mm in diameter by 100 mm long and should weigh between 15 and 30 g.

4.7.2 To the free end of the tape the following force per mm width of tape shall be applied and the tape allowed to hang freely below the tube:

a) For nominal base thickness of 0·012 mm the force shall be 0·7 N/mm tape width.

b) For nominal base thickness of 0·025 mm and 0·036 mm the force shall be 1·5 N/mm tape width.

To the end of the tape and 25 mm above the point of force applied a small strip of double coated adhesive tape shall be affixed to the magnetic side. The tube shall then be slowly and uniformly rotated so that the tape, held in tension by the force, winds uniformly around it into a compact and even roll. The adhesive tape when wound into the test roll, acts to secure the role and prevent its unwinding when the weight is removed.

4.7.3 The tube supporting the rolled tape shall be removed from the winding set-up and subjected to a heat and humidity cycle in which the first 16 hours shall be at 55 ± 2°C and 95 ± 5 percent relative humidity while the final eight hours shall be at 55 ± 2°C dry heat with humidity less than 5 percent. During the humidification and dry heat cycle, the air surrounding the tube is constantly circulated to ensure uniformity of conditions throughout the test area. At the end of the dry heat cycle, the rod shall be removed from the conditioning chamber and allowed to recover under room conditions of approximately 27°C and 65 percent relative humidity.

4.7.4 To evaluate the tape for layer-to-layer adhesion, the end of the roll on the rod shall be carefully opened and the double coated adhesive tape removed. The rod shall then be held between the thumb and fingers and the untapped tape observed to note if the first two or three layers loosen up of their own accord : if this occurs, there is obviously no adhesion and the tape has passed the test, if no loosening or very little loosening of the

outermost layers is observed, the free end of the tape shall be unwound slowly until 225 mm has been unwound. The free end is then allowed to hang and the tape observed to see if it will unwind by itself. If it will not unwind unaided, the rod, with the tape hanging freely, shall be slowly rotated in the direction of tape unwind. If the tape adheres to itself and refuses to begin to unwind after the rod has been rotated through one-fourth revolution or 90 degrees, it shall be considered to have failed in this test. After the rotation test has been made, the free end of the tape shall be held and the rod allowed to fall, thereby unwinding the tape. The unwound tape shall be checked for evidence of coating delamination and in this way the severity of adhesion is established. Any tape which shows any delamination except in the 50 mm nearest the rod, shall be considered as having failed in this test.

4.8 Tensile Strength

4.8.1 Steady Tensile (Rupture Tension) Test — The test shall be carried out in a tensile testing machine capable of continuously indicating the applied stress, for example, one of the pendulum type. A length of tape of not less than 150 mm is clamped between sets of jaws initially set 100 mm apart which are gradually separated at a speed of approximately 300 mm per minute until the specimen breaks, The applied stress shall be continuously indicated as this separation takes place. Breakages at clampings are ignored. Not less than three tests shall be conducted and their arithmetic average is reported as the rupture tension.

4.8.2 Shock Tensile Test (Breaking Strength Under Impulse Loading) — Samples of tapes of length of 100 mm taken from tape reels conditioned as specified in **4.0** shall be placed in an atmosphere of 27 $\pm$ 2°C and relative humidity 65 $\pm$ 5 percent without bends or kinks and allowed to remain for at least 24 hours prior to the test. The sample length of tape shall be clamped at one end and steady stress of 3·0 N/mm^2 is applied at the other end. The sample tape is now subjected to an impulse stress of 3·0 N/mm^2 from a height of 250 mm. At least ten samples shall be tested and the number of breakages noted.

4.9 Elastic Elongation

4.9.1 Elongation after Static Load — A sample length of tape of about 600 mm long is allowed to hang loosely from a rigid clamp under no load for about 24 hours. Before any weight is hung on the sample marks shall be made, one on the top and the other at the bottom, separated over a distance of 500 mm. The distance between the two marks shall be measured accurately to the nearest 0·2 mm without any external tension on the tape. The position of these points shall be observed by a magnifying glass against a fine graduated scale. The following force shall be applied to the tape below the bottom mark, at zero time and allowed to hang undisturbed for

180 minutes ± 30 seconds and then the force shall be removed from the tape:

a) For nominal base thickness of 0·012 mm the force shall be 0·7 N/mm tape width.

b) For nominal base thickness of 0·025 mm and 0·036 mm the force shall be 1·5 N/mm tape width.

The tape shall be then allowed to hang under its own weight for an additional 180 minutes.

The distance between the two marks shall be measured accurately to the nearest 0·2 mm:

a) just prior to the removal of the force, and

b) at the end of 100 minutes after the removal of the force.

The elastic elongation (the difference between the initial and final distances between the marks expressed as a percentage of the initial distance) shall be given as:

a) percentage elongation under force applied for 180 minutes, and

b) percentage elongation measured 180 minutes after the removal of the force.

4.10 Flammability — The tapes shall pass the requirements of burning test specified in IS : 5431-1969*.

5. ELECTRICAL TESTS

5.1 Maximum Output Level

5.1.1 Maximm output level shall be measured using reference bias and in addition be measured at various bias values so that curves may be drawn.

5.1.1.1 At reference frequency the maximum output level at which:

a) 3 percent third harmonic distortion (THD) occurs for reel-to-reel (professional and Hi-Fi application) and

b) 5 percent third harmonic distortion (THD) occurs for reel-to-reel (domestic and cassette tapes) shall be measured.

5.1.1.2 The output level at which five percent intermodulation distortion occurs for reel-to-reel (Hi-Fi application and professional) and cassette (for Hi-Fi application) shall be measured at 9·7 kHz and 0·3 kHz.

5.2 Signal-to-Noise Ratio — Signal-to-noise ratio (*see* **2.7.3**) shall be measured using the reference frequency.

*Definition of motion-picture safety films.

5.3 Distortion — The third harmonic distortion shall be measured at standard reference level.

5.4 Erasability — The tape shall be externally erased. A signal of reference frequency shall be recorded at maximum record level with operating bias and with the erase head operating. The tape shall then be played back with the record and erase heads disconnected to cut off the erase, bias, and record currents. The output of the play-back amplifier shall be connected to a reference frequency band-pass filter and the output of the filter measured in decibels across a 600-ohm load. The tape shall then be passed through a solenoidal coil producing a peak 50 cycles ac field of 1 000 oersteds after which the level of the residual signal on playback shall be measured through a reference frequency band-pass filter. The difference in dB is the effected reduction in signal.

5.5 Tape Sensitivity

5.5.1 Relative tape sensitivity shall be measured at the frequencies and tape speeds indicated with a ' + ' in Table 1 with the signal sufficiently below the reference frequency maximum recording current to ensure linearity and with the reference bias, for the tape under test applied. Relative tape sensitivities shall then be computed (*see* definition) from the values obtained.

TABLE 1 SENSITIVITY TEST REQUIREMENTS

Frequency Hz	Tape Speed					
	38·1 cm/s	19·05 cm/s		9·53 cm/s		4·76 cm/s
		Professional	Domestic	Professional	Domestic	
125	×	×	×	×	×	×
315	+	+	×	+	+	+
1 000	+	+	+	+	×	×
3 150	×	×	+	×	+	+
8 000	×	×	+	×	+	+
10 000	×	+	×	+	×	×
12 500	×	+	+	×	+	+ (for Hi-Fi)
16 000	+	×	×	×	×	×

× = optional; + = mandatory

5.6 Reverse Tape Sensitivity — Reverse tape sensitivity shall be measured at:

a) 16 kHz for tape speeds of 38·1 cm/s and at 1·0 kHz for tape speeds at 19·05 cm/s and 9·53 cm/s for reel-to-reel tape (professional type);

b) 12·5 kHz for reel-to-reel tape (domestic type); and

c) 8 kHz for cassette tape (12·5 kHz for Hi-Fi).

5.7 Frequency Response — A signal at reference frequency shall be recorded at 20 dB below reference level and at operating bias current. The tape shall be played back and the rms output voltage of the playback amplifier of the recorder measured in decibels across a 600-ohm load. This measurement shall be repeated on various frequencies (*see* **3.7.3**) over the specified frequency range of the magnetic tape keeping the input to the recorder constant. The output shall be taken as the difference between reference frequency output and the output at the recording frequencies. The output shall be measured in decibels and the readings shall be corrected for the response of the reference recorder with the readings of the standard reference tape. The response shall be plotted as a function of frequency on a logarithmic scale.

5.8 Print Through — Print through shall be carried out, using a bulk erased tape, at the specified frequency by recording a value of signal current which is necessary to produce reference level from the calibration tape using reference bias from the tape under test. The tape under test is to be fed from the supply spool and a length of tape, less than 1 turn of the outside of a non-magnetic take-up spool, is to be recorded with the test signal. The test signal is to be followed by a length of unrecorded tape using reference bias only, equal to at least 10 turns of the take-up spool. This procedure shall be repeated at least three times. The tape on the storage spool shall then be incubated at 55 $\pm$ 2°C for 4 hours. The tape shall not be rewound before or after incubation.

After incubation the tape shall be replayed and the print through at reference frequency shall be measured by means of filter or wave analyser in conjunction with a pen chart recorder.

5.9 Signal-to-dc-Noise Ratio — A signal at reference frequency shall be recorded at the maximum record level with operating bias current. The tape shall be played back, and the rms voltage output of the playback amplifier of the reference recorder measured in decibels across a 600-ohm load using a 250 Hz high pass filter. This value shall be taken as the signal level. Total harmonic distortion shall also be measured. The tape shall then be externally erased, and a direct current supplied to the record head equal to the rms value of the audio current at maximum record level. Under these conditions the tape is recorded on the reference recorder with operating bias current. The rms output voltage on playback measured above, shall be taken as the dc noise level. The signal-to-dc-noise ratio is the value in decibels of the above signal level minus the value of the above dc-noise level.

5.10 Uniformity Variations (*See* Appendix D) — Uniformity shall be measured at reference bias. Inner, outer or both levels shall be evaluated throughout the reel or a given length of the tape as specified.

5.10.1 *Long Term Variation* — Long term variations shall be measured at frequencies and charts specified below. The signal shall be 20 dB below

maximum recording level to ensure linearity. The signal shall be measured over the entire length to tape on a given reel using a chart recorder:

Type of Tape	*Measurement Frequency* (Hz)
a) Reel-to-Reel	
Professional	250 1 000 and 10 000
Domestic	315
b) Cassette (3·81 mm wide)	
Domestic	315

5.10.2 *Short Term Variation* — Short term variation shall be measured at the frequencies and tracks specified below, with the signal 20 dB below maximum recording current to ensure linearity over a continuous tape length of 250 m or full length of the tape whichever is less using a chart record.

Type of Tape	*Measurement Frequency* (Hz)
a) Reel-to-Reel	
Professional	1 000 10 000
Domestic	3 150
b) Cassette (3·81 mm wide)	3 150

APPENDIX A

(*Clause* 2.1)

REFERENCE TAPE

A-1. An unrecorded magnetic tape with specified characteristics, selected as a reference, to enable a comparison to be made with other magnetic tapes:

a) Reference tapes shall be provided on the basis of a primary standard issued from an agreed carefully measured batch of the tapes listed below and shared among all member national organisations.

b) The measurements on these primary standards shall be certified by the issuing national organization and verified by a second national organization which is able and prepared to do so.

c) Any member country may at its discretion either purchase or manufacture copies to be secondary standards, provided these were certified by their own or another national organization. Copies of reference standards not conforming to this procedure must not be classified as standards.

d) All secondary standards are to be calibrated and issued with correction factors for efficiency, bias ratio and maximum output level expressed relative to the primary standard tape.

e) Quality control of the secondary standards shall be according to an AQL of less than 0·5%.

f) The reference tapes are to be reviewed every two years to ensure they are compatible with currently available tape recorders of the various categories covered by this standard.

g) The reference tape used for tape measurements shall have known efficiency, distortion and bias characteristics, and is required for the following purposes:

1) To determine reference bias for domestic tapes and to serve as a reference for bias ratio for professional and domestic tapes.
2) To determine the relative tape efficiency of the tape under test.
3) To determine correction factors for maximum output levels arising from tolerances in measuring equipment.

h) In order to obtain compatibility between commercial tapes and tape recorders, it is recommended that the appropriate secondary standard reference tape should be used for the alignment of mass produced domestic tape recorders.

j) Table given below shows primary standard reference tapes, their origin and verifying national organizations (where a national organization has no facilities for carrying out these measurements, it may delegate this task to a qualified laboratory in that country).

Tape Speed	*Reference Batch Number*	*Country of Origin*	*Verifying Members*
Professional Use			
19·05 cm/s	A 341 D	Germany	As for
38·1 cm/s	MT 82472	USA	'Domestic Use'
76·2 cm/s	MT 82472	USA	below
Domestic Use			
4·76 cm/s	C 521 V*	Germany	Netherlands
4·76 cm/s	C 401 R	Germany	Japan
4·76 cm/s	CS 301	Japan	Germany
9·53 cm/s	C 264 Z	Germany	Canada
19·05 cm/s	C 264 Z	Germany	UK Czechoslovakia

k) All reference tapes are to be used in conjunction with the time constants specified for the appropriate tape speed.

*Temporary reference tape.

m) Tape widths shall be in accordance with the relevant specifications.

Description	*Typical Coercivity Range*	*To be used with Time Constants* (μs)	
		t_1	t_2
Single layer (For example, Fe_2O_3)	24kA/m—32kA/m	120	3 180
Single layer (For example, CrO_2)	34kA/m—57kA/m	70	3 180
Double layer (For example Fe_2O_3/C_7O_2)	No requirements	70	3 180
Single layer (For example metal pigment)	72kA/m—96kA/m	70	3 180

APPENDIX B

[*Clause* 2.6 (*b*)]

MAXIMUM OUTPUT LEVEL CORRECTION FACTOR

B-1. Procedure to be used to determine the correction factor for maximum output level at all specified frequencies (*see also* Table 2) :

a) Measurement of the maximum output level of the reference tape using reference bias = (A) dB

b) Maximum output level that is specified on an authorized calibration certificate for the reference tape = (B) dB

c) Correction factor for measuring equipment tolerance is = (C) dB (B) — (A)

d) Measurement of the maximum output level of the tape under test using its applicable reference bias = (D) dB

e) Corrected measured value for the tape under test is = (E) dB (D) +(C)

Example:

a) Maximum output level measurement obtained from the reference tape = — 10 dB (A)

b) Maximum output level specified for the reference tape = — 8 dB (B)

c) Correction factor = + 2 dB (C)

d) Maximum output level measurement obtained from the tape under test = — 11 dB (D)

e) Corrected maximum output level value for the tape under test = — 9 dB (E)

NOTE — The maximum output level correction factor is not applicable to reference bias for domestic tapes.

TABLE 2 MAXIMUM OUTPUT LEVELS SPECIFIED FOR DOMESTIC PRIMARY STANDARD REFERENCE TAPES

(Appendix B)

The maximum output levels indicated ϕ below are absolute values obtained from the primary standard reference tapes. When secondary standard reference tapes are used to obtain reference bias, the low frequency maximum output level specified on the authorized calibration certificate should be used.

NOTE — The value of 315Hz (1kHz for 19·05 cm/s) maximum output level used to determine reference bias is derived from the value of bias current which results in a specified difference between the maximum output levels at 10 kHz and 315 Hz (1kHz for 19·05 cm/s tape speed), from the primary reference tape.

TAPE WIDTH mm	TAPE SPEED cm/s	REFERENCE BATCH NO.	TIME CONSTANT IN MICRO SECONDS t_1	t_2	MAXIMUM OUTPUT LEVEL AT* 315Hz	1kHz	MAXIMUM OUTPUT LEVEL AT 10kHz*	MAXIMUM OUTPUT LEVEL DIFFERENCE (dB)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
3·81	4·76	C521 V**	120	3 180	ϕ	—	ϕ	12
3·81	4·76	C401R	70	3 180	ϕ	—	ϕ	12
3·81	4·76	CS301	70	3 180	ϕ	—	ϕ	12
3·81	4·76	To be specified	70	3 180	ϕ	—	ϕ	8
6·30	4·76	C264 Z	120	3 180	ϕ	—	ϕ	12
6·30	9·53	C264 Z	90	3 180	ϕ	—	ϕ	12
6·30	19·05	C264 Z	50	3 180	—	ϕ	ϕ	To be specified

ϕTo be specified by the primary reference tape manufacturer.

*Maximum output levels expressed in dB relative to the reference level recorded on the applicable calibration tape using the standard heads.

**Temporary primary standard reference tape.

APPENDIX C

(*Clause* 3.1)

REFERENCE MAGNETIC TAPE RECORDER

C-1. MAGNETIC TAPE RECORDER (REEL-TO-REEL)

C-1.1 The reference recorder reel-to-reel used for testing according to this standard shall confirm to IS : 8655 (Part III)-1977* except for the following.

C-1.2 Wow and Flutter

C-1.2.1 The speed fluctuation (wow and flutter) shall not be more than 0·15 percent peak weighted when measured in accordance with IS : 8152-1976†.

C-1.3 Tape Tensions

C-1.3.1 Tape tensions at the record and replay heads shall be as follows:

Type of Thickness μm	*Tension* N	
50	0·8	Tolerance + 30 percent — 0 percent
35	0·6	
25	0·4	

C-1.3.1.1 It is recommended that pressure pads shall not be used.

C-1.3.1.2 Starting, stopping and fast winding tension shall not cause any detectable permanent deformation of the tape.

C-1.4 Tape Guides

C-1.4.1 Tape guides shall be such as to ensure stability of measurement without affecting inherent characteristics of the tape.

C-1.5 Heads

C-1.5.1 Full track record and replay heads shall be used with the following gap width. For cassette tapes two track record and replay heads shall be used.

Type of Tape	*Record Gap Length* (μm)	*Replay Gap Length* (μm)
Reel-to-Reel		
Professional	7	3
Domestic	7	2
Cassette		
Commercial	2	1
Domestic	3	1

*Magnetic sound tape recording and reproducing equipment (reel-to-reel): Part III Professional type.

†Method of measurement of speed fluctuations in sound recording and reproducing equipment.

C-1.6 Bias and Erase Supply

C-1.6.1 The frequency of the bias and erase head current shall be between 50 kHz and 100 kHz with a total distortion content of less than 0·05 percent.

C-1.7 Recording Amplifier

C-1.7.1 The recording amplifier shall be adjusted for a constant recording head current characteristics over the specified frequency range. The total distortion shall be less than 0·1 percent for signal levels up to maximum recording level.

C-1.7.2 The amplifier noise shall be at least 20 dB below the tape noise.

C-1.8 Replay Amplifier

C-1.8.1 The replay amplifier and replay head shall be equalized in accordance with the electrical recording/reproducing characteristics specified.

C-1.8.2 The total distortion shall be less than 0·1 percent for signal levels up to the equivalent to maximum output levels.

C-1.8.3 The noise shall be at least 10 dB below the tape noise.

APPENDIX D

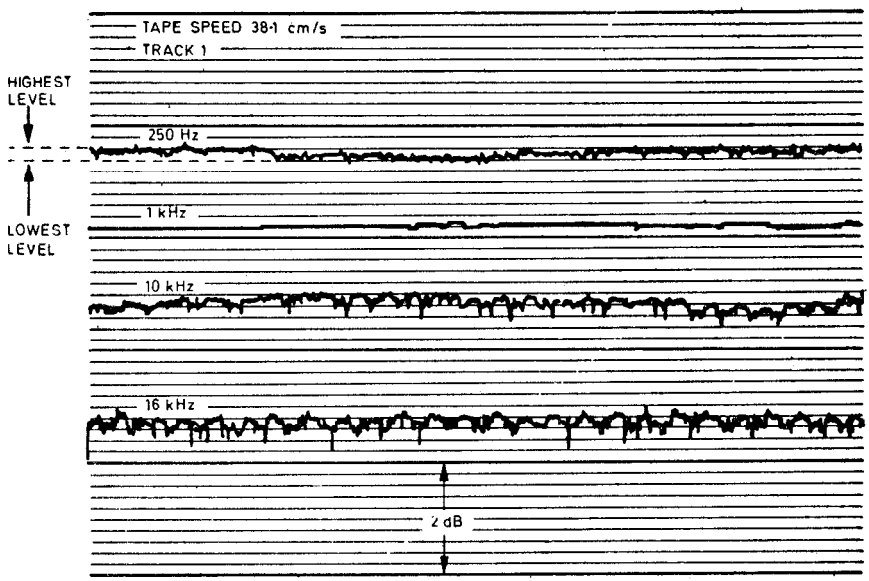
(*Clause* 5.10)

UNIFORMITY MEASURING EQUIPMENT

D-1. Short and long term uniformity variations shall be measured using an RMS pen chart recorder with characteristics as follows:

a) Pen writing speed	500 mm/sec (250 mm/sec for 50 mm paper width)
b) Paper speed	1 mm/sec or greater
c) Paper width	100 mm (50 mm may be used as optional)
d) Measurement scale	100 mm = 10 dB (50 mm = 10 dB when 50 mm paper width is used)

SHORT TERM UNIFORMITY VARIATIONS



EXAMPLE OF PEN CHART READ-OUT

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg. m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

INDIAN STANDARDS INSTITUTION

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002

Telephones : 27 01 31, 26 60 21 **Telegrams : Manaksanstha**

Regional Offices:		Telephone
Western : Novelty Chambers, Grant Road	BOMBAY 400007	37 97 29
Eastern : 5 Chowringhee Approach	CALCUTTA 700072	27 50 90
Southern : C. I. T. Campus, Adyar	MADRAS 600020	41 24 42
Northern : B69, Phase VII S.A.S. Nagar	MOHALI 160051	—
Branch Offices:		
'Pushpak', Nurmohamed Shaikh Marg, Khanpur	AHMADABAD 380001	2 03 91
'F' Block, Unity Bldg, Narasimharaja Square	BANGALORE 560002	2 76 49
Gangotri Complex, Bhadbhada Road, T. T. Nagar	BHOPAL 462003	6 27 16
22E Kalpana Area	BHUBANESHWAR 751014	5 36 27
5-8-56C L. N. Gupta Marg	HYDERABAD 500001	22 10 83
R 14 Yudhister Marg, C Scheme	JAIPUR 302005	6 98 32
117/418 B Sarvodaya Nagar	KANPUR 208005	4 72 92
Patliputra Industrial Estate	PATNA 800013	6 28 08
Hantex Bldg (2nd Floor), Rly Station Road	TRIVANDRUM 695001	32 27

Printed at Delhi Printers, Delhi, India